

The first zoea of three *Pachygrapsus* species and of *Cataleptodius floridanus* (Gibbes) from Bermuda and Mediterranean (Crustacea: Decapoda: Brachyura)

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Introduction

Affinities of larvae belonging to the family Grapsidae have been reviewed by Aikawa (1929), Wear (1970), Rice (1980) and Wilson (1980). Within the four subfamilies composing this family 'the larval development of less than 15% of all the species has been described' (Wilson, 1980: 756). Many descriptions are insufficient for meaningful comparative studies and, because of the apparent difficulty of rearing these small zoeae, a large percentage of studies describe only the first stage.

Wilson (1980) has provided a useful and comprehensive table of seven comparative features of the first stage zoeae of 47 grapsid species. To this list may be added the following accounts which contain more or less adequate details for comparative purposes. Plagusiinae: *Plagusia depressa*, Rice & Williamson, 1977. Varuninae: *Eriocheir japonica*, *Gaetice depressus*, *Hemigrapsus longitarsus*, *H. penicellatus*, *H. sanguinensis*, Terada, 1981. Grapsinae: *Metopograpsus latifrons*, Kakati, 1982; *M. messor*, Rajabai, 1962. Sesarminae: *Aratus pisonii*, Hartnoll, 1965; *Chasmagnathus convexus*, Saba, 1974; *C. laevis*, *Helograpsus haswellianus*, Green & Anderson, 1973; *Metasesarma rousseauxi*, Rajabai, 1962; *Sesarma erythroductyla*, Green & Anderson, 1973; *S. perracae*, Soh Chen Lam, 1969; *S. tetragonum*, Rajabai, 1962.

Within the genus *Pachygrapsus* larval stages are known for only three of the fifteen or so accepted species (viz. *P. marmoratus*, *P. transversus*, *P. crassipes*). Of these, the complete development has been described for *P. marmoratus* (Fabricius) and *P. crassipes* Randall. Larval descriptions of *P. marmoratus* are based, except for the first stage, upon plankton collected material (see Cano, 1892; Hyman, 1924; Bourdillon-Casanova, 1960), but some of Cano's figures, also reproduced by Hyman, may not even be of a *Pachygrapsus* (see p. 000). Laboratory hatched first stage zoea of *P. transversus* was described superficially by Lebour (1944) and Rossignol (1957) identified a plankton caught megalopa to this species. Villalobos (1971) described the first zoeal stage of *P. crassipes*. This species was laboratory reared to fifth zoeal stage by Schlotterbeck (1976) and a plankton caught megalopa was tentatively assigned to *P. crassipes* by Rathbun (1923).

During 1973 first stage zoeae of *Pachygrapsus marmoratus* were obtained from a laboratory held crab collected by R. B. Manning off the coast of Tunisia and in 1983 the first stage zoeae of *P. gracilis* and of *P. transversus* were hatched from crabs held by the author in the Biological Station, Bermuda. Although the larvae of these species were not reared beyond the first zoeal stage it would seem desirable to give an account of this material to supplement meagre larval information at present available on this genus and also to compare (see Table) the first stages of these four *Pachygrapsus* species. Opportunity is also taken to describe the first stage zoea of the xanthid *Cataleptodius floridanus* (also hatched at Bermuda), the larvae of which were studied by Kurata (1970) but whose account was never published (see Martin 1984: 233, footnote).

Materials and methods

The first zoea of *P. marmoratus* was hatched from a crab collected in the canal leading from

Table 1. Comparative features of *Pachygrapsus* first zoeal stage

FEATURE	<i>P. gracilis</i> (present material)	<i>P. transversus</i> (present material)	<i>P. crassipes</i> (Schlotterbeck 1976) ¹	<i>P. marmoratus</i> (present material)
Dorsal spine/C.L.	0.60-0.70 mm	0.60-0.70 mm ²	0.90 mm	0.75 mm ³
Carapace, postero-lateral margins	denticles conspicuous	denticles inconspicuous	denticles conspicuous	denticles very inconspicuous ⁴
Antennule, aesthetascs/setae numbers	4	4 ⁵	3	4
Antenna, spinous process investment	denticles few and obtuse on distal part	denticles numerous long and subacute on distal part	two small acute denticles only on distal part	denticles small ⁶ acute and numerous on distal part
Maxilla, coxal endite, setae	9 (4+5)	9 (4+5)	78 (4+4) ⁷	9 (4+5)
Abdomen, fourth segment	laterally expanded, with obtuse dorso-lateral processes	laterally expanded, with obtuse ⁸ dorso-lateral processes	slightly laterally expanded, with minute dorso-lateral processes	not laterally expanded dorso-lateral processes absent ⁹
Telson, lateral spines on furcae	both very minute	minute, one larger than ¹⁰ the other	absent	absent ¹¹

¹Schlotterbeck tabulates several additional features by which his account differs from the one given by Villalobos (1971); ²Lebour (1944) gives 0.9 mm; ³Bourdillon-Casanova (1960) gives 1.10 mm and ⁴shows these denticles as conspicuous; ⁵Lebour shows 3 setae; ⁶Bourdillon-Casanova shows these as conspicuous; ⁷Villalobos states 7 setae; ⁸Lebour shows these as large, curved and acute; ⁹the conspicuous processes shown on this segment by Bourdillon-Casanova are the large denticles on the postero-lateral margins (see Fig. 3h inset); ¹⁰Lebour shows these equally developed; ¹¹Bourdillon-Casanova shows these as very conspicuous although 'très fines', they are absent in all specimens examined.

southern Punic Port, Salamambo, Tunisia, 18.7.1973. Oviparous *Pachygrapsus gracilis* and *Cataleptodius floridanus* were collected at various localities from the intertidal mud flats at Ferry Reach and *P. transversus* from beneath stones at Whalebone Bay, Bermuda, all in September/October 1983. The eggs hatched within 2–3 days of the crab's confinement in aerated aquaria water held at 20–24°C and the larvae were fed newly hatched *Artemia* nauplii. Live zoeae were subsequently transported to a rearing laboratory at the British Museum (Natural History) in London but none survived to the second stage.

Measurements given are: T.T. = distance between tips of dorsal and rostral spines; C.L. = carapace length from between the eyes to the postero-lateral margin. The material has been incorporated in the Collections of the British Museum (Natural History), accession number: 1985: 463–468.

Descriptions

Family GRAPSIDAE MacLeay, 1838
Subfamily GRAPSINAE MacLeay, 1838

Pachygrapsus gracilis (de Saussure, 1858)

Dimensions: T.T. 0.60–0.70 mm. C.L. 0.35–0.38 mm.

Carapace (Fig. 1a): dorsal spine short and straight, stout proximally, slightly more than one third carapace length; rostral spine of moderate length and stout; dorso-median elevation prominent; at least four pairs of antero-median setules and a pair of postero-median setules present; postero-lateral margins of carapace narrowly rounded with 3–4 obtuse denticles and lateral microscopic setules (inset to fig.).

Eyes: partly fused to carapace.

Antennule (Fig. 1b): unsegmented with four aesthetascs/setae.

Antenna (Fig. 1c): spinous process as long as rostral spine and with many subacute denticles; exopod very small, about one ninth of spinous process length.

Maxillule (Fig. 1d): endopod 2-segmented, proximal segment with one seta, distal with one subterminal and four terminal setae; basal endite with five spines, coxal with six spines/setae.

Maxilla (Fig. 1e): endopod stepped distally, outer lobe broader than inner each with two long setae; basal endite incipiently bilobed distally, each with four setae; coxal endite bilobed distally, outer lobe with four and inner with five setae respectively, seta on apex of outer lobe very short almost a spine; scaphognathite with four plumose setae and a stout posterior process.

First maxilliped (Fig. 1f): basis with eight setae arranged in pairs; endopod five-segmented with 1, 2, 1, 2, 4 + 1 setae; exopod incipiently two-segmented and with four terminal plumose setae.

Second maxilliped (Fig. 1g): basis with four setae; endopod three-segmented with 0, 1, 4 + 1 setae; exopod incipiently two-segmented with four terminal plumose setae.

Third maxilliped and *pereiopods*: not developed.

Abdomen (Fig. 1h): composed of five segments and a telson, somewhat dorso-ventrally compressed, surfaces with microscopic spinules; second and third segments with a pair of broad dorso-lateral processes; fourth segment laterally expanded and with a pair of obtuse lateral processes placed at a lower level than the ones on preceding segments; first segment, postero-lateral margins truncate, those of other segments obtuse and of third to fifth with a very minute denticle; second to fifth segments each with a pair of setules near postero-dorsal margin. Telson somewhat narrowed, furcae not noticeably directed outwards, each with numerous microscopic spinules and two very small lateral spinules; posterior margin with six equal plumose setae.

Pachygrapsus transversus (Gibbes, 1850)

Pachygrapsus transversus: Lebour, 1944: 115, fig. 5 (zoea I); Rossignol, 1957: 89, fig. 5 (megal.).

Dimensions: T.T. 0.60–0.70 mm. C.L. 0.30–0.35 mm. Differs from *P. gracilis* in the following features.

Carapace (Fig. 2a): dorsal spine longer and proximally slightly stouter, more than one third of carapace length; rostral spine noticeably stouter proximally; postero-lateral margin of carapace with very inconspicuous denticles and with microscopic setules; only two pairs of antero-median setules apparent.

Antenna (Fig. 2c): spinous process with numerous subacute denticles developed distally as stout spine-like processes; exopod about one seventh of spinous process length.

Maxillule (Fig. 2d): spines/setae slightly stouter.

Maxilla (Fig. 2e): basal endite noticeably bilobed distally.

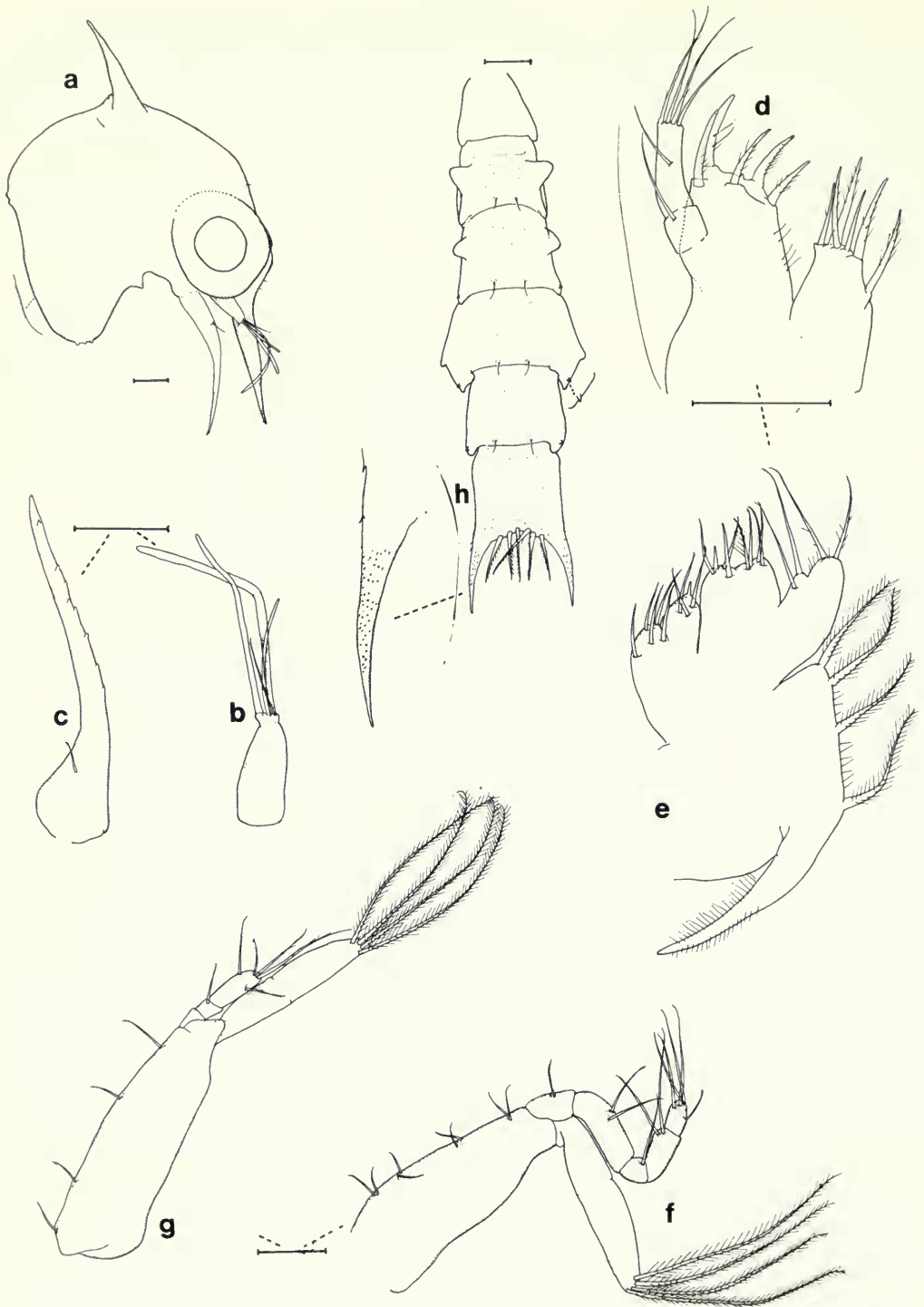


Fig. 1. *Pachygrapsus gracilis* (de Saussure). First zoea. a, carapace, right lateral aspect; b, antennule; c, antenna; d, maxillule; e, maxilla; f, first maxilliped; g, second maxilliped; h, abdomen and telson, dorsal aspect. Scale = 0.05 mm.

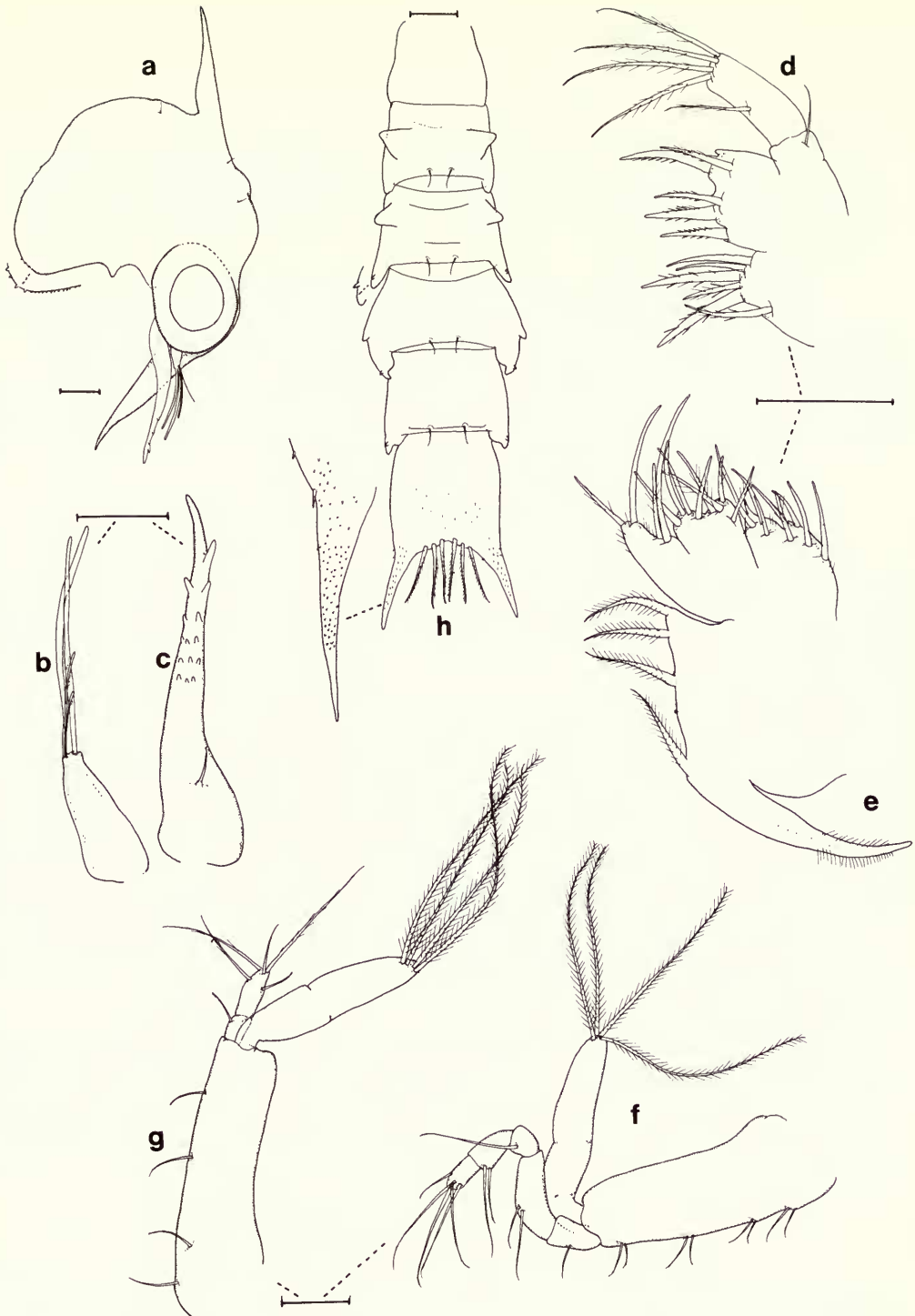


Fig. 2. *Pachygrapsus transversus* (Gibbes). First zoea. a, carapace, right lateral aspect; b, antennule; c, antenna; d, maxillule; e, maxilla; f, first maxilliped; g, second maxilliped; h, abdomen and telson, dorsal aspect. Scale = 0.05 mm.

Abdomen (Fig. 2h): slightly larger, postero-lateral margins of fourth segment subacute and of the other segments (except first) more produced, denticles larger. Telson slightly broader, the more posterior of the two lateral spinules larger; furcae slightly shorter and stouter.

***Pachygrapsus marmoratus* (Fabricius, 1787)**

Pachygrapsus marmoratus: Cano, 1892: 8.Tav.III, figs 1B (?zoea III), ?1C, 1E, 1F, ?2c, 2e-f, ?3c, 4e-f, 5e-f, 6e-f, 7e-f, 8e-f (labelled as 6 in fig.), 12e, 13e, 14e, 15e (?zoea IV, megal.); Williamson, 1915: 518, figs 403-405, 407-8 (figs after Cano); Hyman, 1924: 2, Pl. 3, figs 22, ?23, 25, 26, ?33, 36a-b, 41, 42, 44, 45, 48, 49, 50, 52, 53, 54, 56 (figs after Cano); Bourdillon-Casanova, 1960: 188, fig. 61 (zoea I); Paula, 1985: 142, fig. 3 (zoea I).

Dimensions: T.T. 0.75 mm. C.L. 0.35 mm.

Differs from *P. gracilis* and *P. transversus* as follows.

Carapace (Fig. 3a): dorsal spine longer, exceeding half carapace length; postero-lateral margin of carapace without setules, denticles very minute; antero-median setules not apparent.

Antenna (Fig. 3c): denticles on spinous process small and numerous throughout length of process.

Maxillule (Fig. 3d): setules on spines/setae very long.

Abdomen (Fig. 3h): fourth segment not laterally expanded and without a pair of obtuse lateral processes; postero-lateral margins of third to fifth segments each with a conspicuous denticle. Telson lateral spinules on furcae absent.

Family XANTHIDAE MacLeay, 1838

***Cataleptodius floridanus* (Gibbes, 1850)**

Dimensions: T.T. 1.1 mm. C.L. 0.43 mm.

Carapace (Fig. 4a): dorsal spine long, distally curved, proximally stout; rostral spine almost as long as dorsal spine and with 1 or 2 small spinules; lateral spines small; dorso-medial elevation hardly developed; no antero-median setules apparent, a small pair of postero-median setules present; postero-lateral margin of carapace with one or two small setules.

Eyes: partly fused to carapace.

Antennule (Fig. 4b): unsegmented and with four aesthetascs/setae.

Antenna (Fig. 4c): spinous process as long as rostral spine, distally with many long acute spines; exopod small, between one sixth and one seventh of spinous process length and with two small distal setules.

Maxillule (Fig. 4d): endopod two-segmented, proximal segment with one distal seta, distal segment with five setae (two subdistal and three distal); basal endite with five spines/setae; coxal endite with seven setae.

Maxilla (Fig. 4e): endopod two-lobed, outer slightly stepped, broader than inner and with 2+2 setae, inner lobe with three setae; basal endite two-lobed, outer prominent and with four setae, inner with five setae; coxal endite two-lobed each with four setae; scaphognathite with four plumose setae and a stout posterior process.

First maxilliped (Fig. 4f): basis with ten setae arranged 2, 2, 3, 3, respectively; endopod five-segmented, with 3, 2, 1, 2, 4+1 setae respectively; exopod incipiently two-segmented with four terminal plumose setae.

Second maxilliped (Fig. 4g): basis with four setae; endopod three-segmented, with 1, 1, 4+1 setae respectively; exopod incipiently two segmented, with four terminal plumose setae.

Third maxilliped and *pereiopods*: not developed.

Abdomen (Fig. 4h): composed of five segments and a telson; second segment with a pair of subacute laterally directed dorso-lateral processes, third segment with a pair of small acute posteriorly directed dorso-lateral processes; postero-lateral margins of second segment acute, those of third to fifth segments extended into acute processes; postero-dorsal surface of second to fifth segments each with a small pair of setules near margin; posterior margins of segments four and five with minute denticles. Telson furcae diverging slightly, each with one long prominent dorsal spine and one long and one smaller lateral spine, furcae with minute denticles; posterior margin of telson with six long setae.

Remarks

As mentioned earlier, some of the stages described and figured by Cano (1892) as *Pachygrapsus marmoratus* may not belong to this species. His figure depicting a first stage zoea (Tav.III, Fig. 1A) does not show a dorso-lateral process on the third segment of the abdomen characteristic of *Pachygrapsus* zoeae and obvious in the present laboratory reared material. Cano's figure 1B clearly shows this lateral process and although this larva is depicted with four maxillipedal exopod setae it

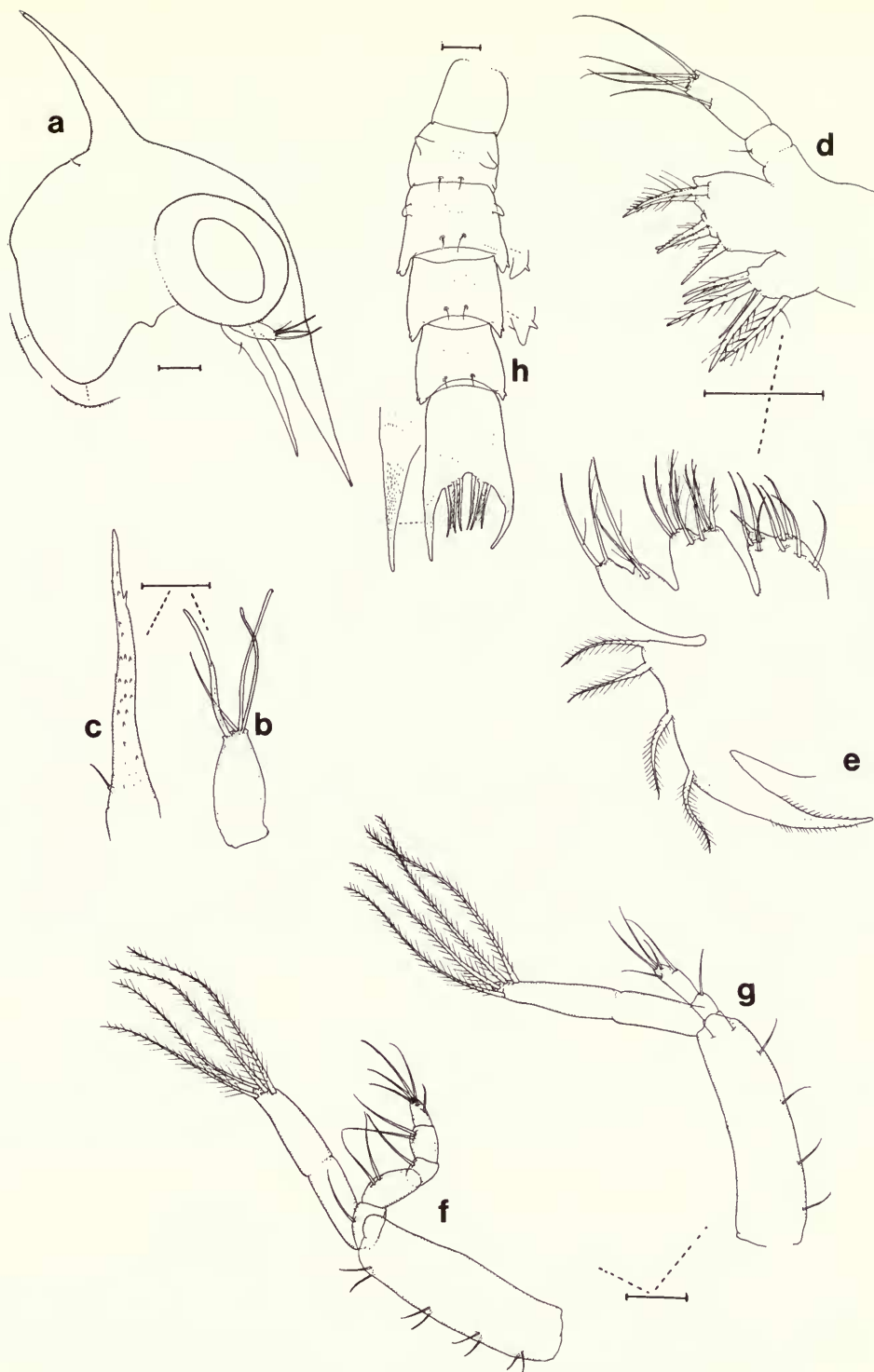


Fig. 3. *Pachygrapsus marmoratus* (Fabricius). First zoea. a, carapace, right lateral aspect; b, antennule; c, antenna; d, maxillule; e, maxilla; f, first maxilliped; g, second maxilliped; h, abdomen and telson, dorsal aspect. Scale = 0.05 mm.

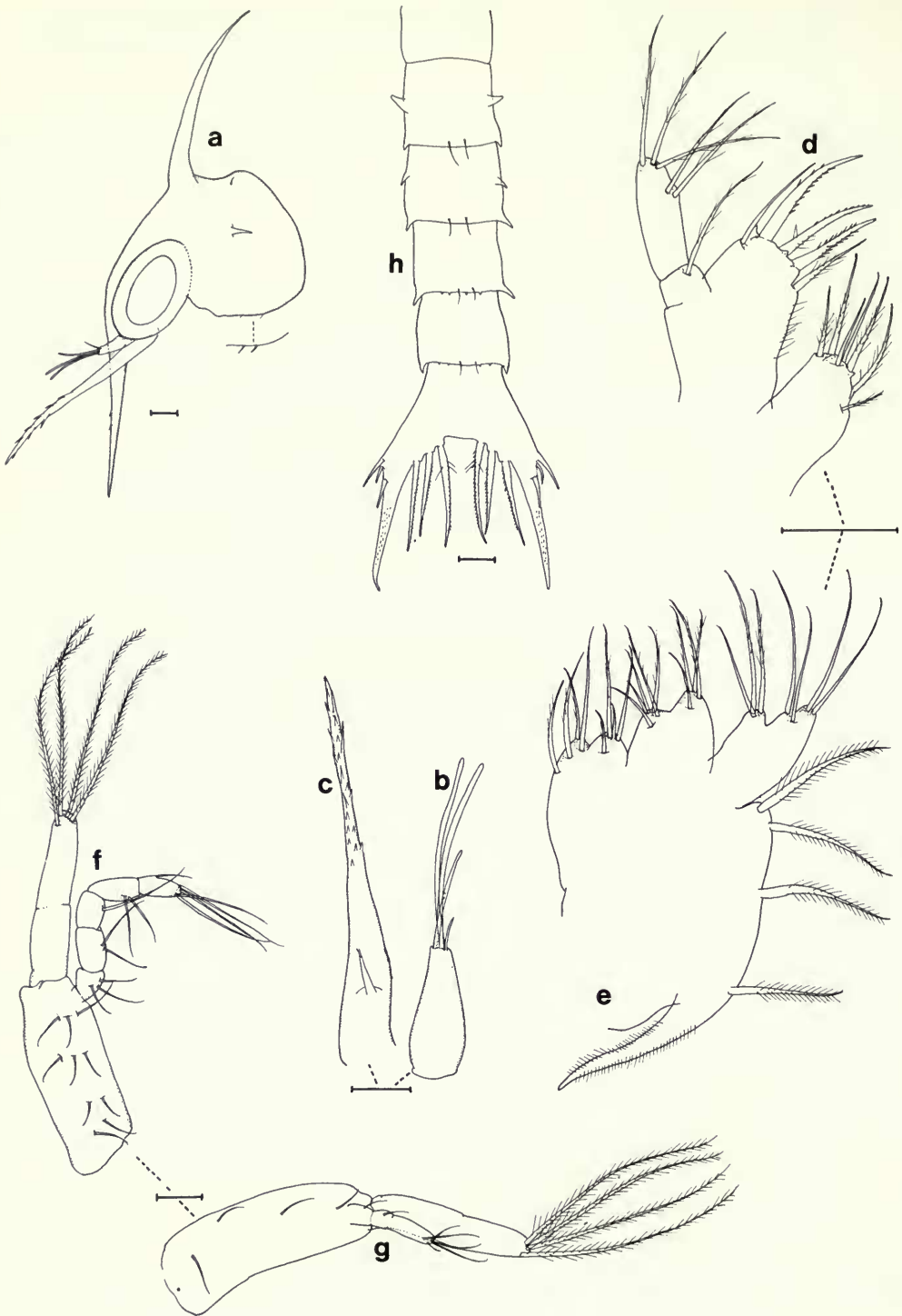


Fig. 4. *Cataleptodius floridanus* (Gibbes). First zoea. a, carapace, left lateral aspect; b, antennule; c, antenna; d, maxillule; e, maxilla; f, first maxilliped; g, second maxilliped; h, abdomen and telson dorsal aspect. Scale = 0.05 mm.

is probably of a later stage because he figures incipient pereopods beneath the carapace. Hyman (1924) has suggested that this is a stage three zoea and was also convinced that Cano had overlooked a fourth stage and that the third stage described by Cano (purporting to be the last) represented the fifth and terminal zoeal stage of this species. Costlow & Bookhout (1962) however, maintained that . . . 'While some of Cano's (1891) figures may bear some slight inaccuracies, it is quite possible that the sequence and number of larval stages which he figures is correct. . .' These views were expressed in the context of their study of the larval development of *Sesarma reticulatum* in which there are only three zoeal stages and it is probable that *P. marmoratus* passes through five stages similar to *P. crassipes*. Cano (1892) also assigned two megalopal forms to *P. marmoratus*. The one illustrated in his fig. ID and bearing an acute rostral projection appears to be of an oxyrynch as it lacks dactylar subterminal setae on the fifth pereopods characteristic of brachyrynch megalopas. Bourdillon-Casanova (1960) described the first stage zoea of *P. marmoratus* from laboratory hatched material and illustrated (Fig. 61) prominent denticles on the carapace postero-lateral margin as well as two conspicuous lateral setae (also shown by Paula, 1985, Fig. 3,i) on each furca of the telson. These two features could not be detected in specimens examined during the present study. Lebour's (1944) figure of the first zoea of *P. transversus*, also obtained from Bermudan laboratory hatched crabs, differs from the present specimens in apparently having two distal setae on the antennal spinous process, a pair of conspicuous curved, acute dorso-lateral processes on the fourth abdominal segment and two equally developed lateral spinules on the telson furca. Her zoeae were also larger than the present ones.

Mid-dorsal carapace setules have never been mentioned previously as occurring in *Pachygrapsus* zoeae, and Gore & Scotto (1982: 518) suggested they may be absent in grapsinid zoeae. However in the present study these setules were found in first stage zoeae of *P. gracilis* and *P. transversus* but were not apparent in *P. marmoratus*. They are somewhat difficult to resolve satisfactorily, even with the aid of interference contrast, but appear to be less numerous on the antero-median region of *P. transversus* than of *P. gracilis*. In many brachyuran larvae these setules do not appear until later stages.

Martin (1984: 232–233) has provided an excellent key to the known xanthid zoeae of the Western Atlantic and Gulf of Mexico. The present study confirms his assessment of the larvae of this species as belonging to his group I of the xanthidae and they can be assigned to *C. floridanus* on the following combined features: (1) lateral processes of third to fifth abdominal segments not extending posteriorly beyond half length of following segment, (2) more than twenty spinules on spinous process of antenna, (3) abdominal dorso-lateral processes confined to second and third segments, (4) telson with three spines on each furca, (5) lateral carapace spines present, (6) basal segment of first maxilliped endopod with three setae, (7) antennal exopod very reduced.

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